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DESCRIPTION OF A PERMIAN CRINOID FAUNA FROM TEXAS

STUART WELLER

The crinoid fauna here described was collected by Professor J. A. Udden in Presidio County, Texas. The specimens are all from the lower brecciated bed of the Cibolo limestone[1] in the east bluff of Sierra Alta creek three miles north of Shafter and one-half mile below Cibolo ranch. The fauna is of interest because it is the first prolific crinoid fauna described from the Permian of this country. The members of the fauna constitute an interesting assemblage of species, most of which belong to the family *Encrinidae* which is restricted in range to the late Paleozoic and the Triassic. The members of this family are characterized by the development of strong articulating ridges upon the distal faces of the radial plates and by the reduction and sometimes by the elimination of the anal plates in the dorsal cup. The only species here described which does not belong to this family is *Hydreionocrinus uddeni*, one of the *Poteriocrinidae* also having strong articular ridges on the radials, but having a full quota of anal plates and a large ventral sack. Besides the species here described there are numerous detached plates in the collection which indicate the presence of nearly as many more species, and many crinoid columns of various sizes and forms, the largest of which attain a diameter of 40^{mm} or more.

In comparing the fauna with similar faunas in other parts of the world, mention must be made of the echinoderm fauna of the upper marine series of the Permo-Carboniferous of New South Wales[2] and that of the Productus limestone of the Salt Range in India.[3] The species here described as *Phialocrinus americanus* must be compared directly with *P. princeps* Eth., from the Australian horizon, and, aside from the specimens here described under the generic name *Cibolocrinus*, the only related crinoid with underbasals reduced to three in number is *Tribrachiocrinus* from the same Australian beds. *Cibolocrinus* differs from the Australian *Tribrachiocrinus* only in the absence of the radianal plate from the calyx.

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[1] Univ. Texas Min. Surv., *Bull. No. 8*, p. 20.

[2] *Mem. Geol. Surv. N. S. W.*, "Paleontology," No. 5, Part 2.

[3] *Pal. Indica*, Ser. XIII, Vol. I, pp. 822–34.

The species recognized by Waagen in the Salt Range of India are somewhat similar to the Texas forms. Two species described under the names *Cyathocrinus indicus* and *C. kattaensis* are clearly not members of that genus and should be referred to some genus, perhaps as yet undescribed, in the family *Encrinidae*. They are very similar in general form to the turbinate species of *Cibolocrinus* from Texas, and are to be distinguished from them only in having the full quota of five underbasal plates. The plates from the same fauna described as *Cyathocrinus goliathus* are very like the similar plates of *Phialocrinus americanus* from Texas and those of *P. princeps* from Australia.

Description of Species

HYDREIONOCRINUS UDDENI n. sp.

(Plate I, Figs. 1–5)

Description.—Dorsal cup saucer-shaped, 42^{mm} in maximum diameter and 12^{mm} in depth. The base deeply excavated for the attachment of the column, all sutures of the calyx, except those between the underbasal plates, situated in groovelike depressions, the surfaces of the plates convex. The underbasal plates form a pentagonal disk 15^{mm} in diameter with a deep, central, circular depression with sides slightly converging toward the bottom, the width of the stem facet is 9.6^{mm}, the width of the depression at its rim is 12.5^{mm}, and the depth of the depression 3^{mm}; the distal extremities of the underbasals, beyond the rim of the columnar depression, are short and convex or nodelike. The basal plates large, wider than high, the two anterior ones and the left posterior one uniform in size and shape, being pentagonal with the basal and two distal margins of nearly equal length, the lateral margins not more than one-third the length of the other margins; the outlines of the posterior and right-posterior basals are modified by the introduction of the large radianal, these plates being in the main pentagonal, but not symmetrically so as are the other three. The radial plates large, about twice as wide as high, pentagonal in outline, marked by strong articular ridges on their distal faces. Radianal plate large, its width about two-thirds its length, its area about equal to that of the adjacent basals, its general outline quadrangular but really pentagonal, the distal face supporting the first tube plate being very short, the proximal angle of the plate in contact with the distal angle of the right posterior underbasal. Anal plate imperfectly preserved in the type specimen, but apparently smaller than the radianal. The first tube plate is incorporated in the calyx at least in its proximal region.

Neither the arms nor the ventral sack of the species have been observed, but accompanying the dorsal cup are a number of large, spatulate, spinous plates which characteristically form the border of the distal surface of the mushroom-shaped ventral sack in this genus. These plates probably represent the same species as the cup, and their form and size is such as to indicate that about 15 of them formed the border of a disk 60 or 70^{mm} in diameter, exclusive of the spinous projections of the plates.

Remarks.—This species is characterized by its great size, the only form at all comparable with it in this respect being *H. kansasensis* from the upper Pennsylvanian of Kansas which is nearly of equal size. It differs from the Kansas species in its smaller underbasal disk, in the deeply excavated base for the attachment of the column, in the slighter contact of the radianal plate with the underbasals, and especially in the outline of the basal plates which are pentagonal rather than triangular.

PHIALOCRINUS AMERICANUS n. sp.

(Plate I, Figs. 8, 9)

Description.—Dorsal cup large, subglobose, the diameter of the type specimen approximately 47^{mm} and its height approximately 30^{mm}. The surface of the plates smooth, all the sutures except those between the underbasals situated in shallow and narrow grooves. Underbasals forming a shallow, saucer-shaped basin which is visible in a side view, its diameter being about 22^{mm} in the type specimen, the stem facet but slightly depressed below the surface of the plates, its diameter about one-third that of the underbasal disk. Basal plates large, all except the posterior one hexagonal but with the two proximal faces in nearly a straight line and together about equal in length to each one of the other sides so that the general outline of the plates is nearly regularly pentagonal, the height and width of each of these plates in the type specimen is about 24^{mm}; the posterior basal is not complete in the type specimen but it is probably similar to the others except in being somewhat wider and in having the distal angle truncated for the reception of an anal plate. Radials large, pentagonal, wider than high. Anal plate not present in the type specimen, probably quadrangular or pentagonal in outline and resting upon the truncated distal end of the posterior basal between the two posterior radials.

Remarks.—Unfortunately the type and only specimen of this species is imperfectly preserved and somewhat distorted, so that it is not possible to give accurate measurements. The posterior side has been destroyed by weathering so that it is not possible to be certain in regard to the form and position of the anal plate. It is certain, however, that no radianal plate is present in the calyx, but the presence of a small anal plate is more than probable. The posterior basal is broader than any of the other plates of the basal ring, and the two posterior radial plates when projected posteriorly to a width equal to the width of the remaining radials leave a space of about 7^{mm} to be occupied by an anal plate.

The nearest allies of the species are found in *P. princeps* Eth., and *P. konincki* Clarke, from the upper marine series of the Permo-Carboniferous of New South Wales.[1] It differs from *P. konincki* in the convex rather than concave underbasal disk, and from *P. princeps* it differs in its flatter plates with less deeply impressed sutures. From both of these Australian species it differs in its smaller size. In general form the species resembles *Ulocrinus blairi* M. & G., but it may be easily distinguished by the absence of the radianal plate which is very large in that species, and by the relatively broader underbasal disk.

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[1] *Mem. Geol. Surv. N. S. W.*, "Paleontology," No. 5, Part 2, pp. 107–10 (1892).

DELOCRINUS MAJOR n. sp.

(Plate I, Figs. 6, 7)

Description.—Dorsal cup large, basin-shaped, with a deep basal excavation, the surface of the plates flat, the sutures flush with the surface, not depressed in furrows. The dimensions of the type specimen are: diameter of dorsal cup, approximately 40^{mm}, height of same 14^{mm}. Underbasals small, nearly covered by the column, situated in the bottom of the basal excavation. Basals large, a little longer than wide, their proximal portion to the extent of nearly one-half of the total length of the plates inflected to form the sides of the basal excavation, the distal portion forming the lower part of the flaring sides of the cup, four of them angular at their distal extremities, the posterior one truncated to support the anal plate. Radial plates large, nearly twice as wide as high, pentagonal in outline, forming more than half of the flaring sides of the cup. Anal plate higher than wide, hexagonal in outline, resting between the posterior basals upon the truncated distal extremity of the posterior basal and extending for nearly one-half its height above the level of the radials, its surface convex along the median longitudinal line and concave transversely along the line joining the two lateral angles. Radianal plate absent.

Remarks.—This species is described from an incomplete dorsal cup, the type specimen being approximately one-half of an individual broken vertically. The portion of the specimen preserved is undistorted and retains the posterior side, so that all the essential characters are preserved. The species is especially characterized by its large size, it being nearly twice as large as the Pennsylvanian species which usually represent the genus. In general form it resembles the common *D. hemisphericus* but has much straighter flaring sides and a proportionally larger anal plate.

DELOCRINUS TEXANUS n. sp.

(Plate I, Figs. 12, 13)

Description.—Dorsal cup basin-shaped, broadly excavated at the base, the surface of the plates convex, the sutures slightly impressed, especially the lateral sutures of the basal plates and at the distal extremities of the same plates. The dimensions of the type specimen are: diameter of dorsal cup 20^{mm}, height of same 7^{mm}. Underbasals situated in the bottom of the basal excavation, the diameter of the underbasal disk being about 5.5^{mm}, the columnar facet circular, its diameter about one-half the diameter of the underbasal disk. Basal plates large, longer than wide, the proximal portion forming the sloping sides of the basal excavation, the distal portion sloping outward and upward, the distal extremities angular in all except the posterior plate which is truncated for the reception of the anal plate. Radial plates large, about twice as wide as high, pentagonal in outline, their distal faces furnished with strong articular ridges. Anal plate small, resting between the posterior radials upon the truncated distal extremity of the posterior basal, pentagonal in outline, the distal extremity angular and extending somewhat beyond the level of the radials.

Remarks.—This species is based upon a single very perfect dorsal cup which is similar in size to *D. hemisphericus* (Shum.). It differs from that species, however, in the larger underbasal plates, the broader basal excavation, and in the convexity of the plates, the surface of *D. hemisphericus* being even throughout with the sutures flush with the general surface.

DELOCRINUS EXCAVATUS n. sp.

(Plate I, Figs. 16, 17)

Description.—Dorsal cup basin-shaped, deeply and broadly excavated at the base, the plates a little convex, the sutures impressed in shallow grooves. The dimensions of a dorsal cup are: diameter 20^{mm}, height 7^{mm}. Underbasal plates entirely included in the basal excavation which in the type specimen has a diameter of 8^{mm} at its margin and a depth of 3^{mm} or more, with nearly vertical sides. Basal plates rather large, their proximal borders incurved to form the sides of the basal excavation, the distal extremities angular except the posterior one which is truncated to support the anal plate. Radial plates large, much wider than high, pentagonal in outline, their distal faces furnished with articulating ridges. Anal plates two in number, together occupying the position of the single anal plate which is commonly present in this genus, upon the truncated distal extremity of the posterior basal, the two plates are of nearly equal size, being separated by a vertical suture nearly midway in position between the posterior lateral margins of the two posterior radials, the distal extremities extend beyond the level of the radial plates.

Remarks.—This species is established upon a single dorsal cup and is characterized by its broad and deep basal excavation with nearly vertical sides, and by the presence of two plates in the posterior interradial area which is usually occupied by a single anal plate. From the single example of the species available for study, it is not possible to determine whether this latter character is normal or whether it is an abnormal condition. If it is the normal condition of the species then the second plate is probably to be interpreted as the first tube plate which is not infrequently present in the dorsal cup of crinoids in which a radianal plate is present. Its presence in this form, however, not associated with a radianal plate is a very exceptional condition and might be considered as of generic value.

ERISOCRINUS PROPINQUUS n. sp.

(Plate I, Figs. 14, 15)

Description.—Dorsal cup basin-shaped, perfectly symmetrical, the sutures between the plates flush with the general surface. The dimensions of the type specimen are: diameter of the dorsal cup 18^{mm}, height of same 9.5^{mm}. Underbasal plates forming a slightly concave, pentagonal disk 6.5^{mm} in diameter, the central portion of which is occupied by the circular columnar facet 4^{mm} in diameter. Basal plates all similar in form and size, hexagonal in outline, but with the two proximal faces meeting in a very obtuse angle and together nearly equal in length to one of the lateral faces, so that the general outline of the plates is pentagonal, the proximal portions of the plates nearly horizontal in position but rapidly curving upward so that the major portion of the plates slopes upward and outward. Radial plates much broader than high, pentagonal in outline, the distal faces bearing well-defined articular ridges. No anal plate present.

Remarks.—This species is established upon a single nearly complete dorsal cup which resembles and is closely allied to *E. typus.* It differs from that species, however, in the somewhat broader basal truncation of the dorsal cup, which is also porportionately higher, and consequently in the somewhat less divergent sides, also in the shallow concavity of the underbasal disk and in the longer lateral faces of the basal plates.

ERISOCRINUS TRINODUS n. sp.

(Plate I, Figs. 10, 11)

Description.—Dorsal cup turbinate, the sides nearly straight, diverging from the base at an angle of a little less than 90°, the sutures between the plates flush with the general surface, not situated in depressed grooves. The dimensions of the type specimen are: diameter of dorsal cup 14.5^{mm}, height of same 9^{mm} Underbasal plates five, less than one-half of their proximal extremities covered by the columnar facet, the exposed portions of the plates smooth, forming the flaring sides of a shallow cup. Basal plates smooth, wider than high, hexagonal in outline, their distal extremities angular, the two distal faces longer than any of the others, the two proximal faces meeting in an angle so obtuse that the two together make nearly a straight line. Radial plates much wider than high, pentagonal in outline, the surface curving inward toward the distal margin, each bearing three distinct nodelike tubercles symmetrically arranged, one near each lateral margin of the plate with the third situated lower down on the median line of the plate. No anal plate present.

Remarks.—This species is based upon a single nearly complete but somewhat weathered dorsal cup. In general shape it resembles *E. conoideus* M. and W., from the Pennsylvanian at Springfield, Ill., but it is much larger and is characterized by the presence of the three nodelike tubercles upon each radial plate.

CIBOLOCRINUS n. gen.

Description.—Dorsal cup basin-shaped or turbinate. Underbasal plates three, two large and one small, the larger plates formed by the fusion of the right and left pairs. Basal plates large, the anterior pair hexagonal in outline, the right and left postero-lateral ones pentagonal, the posterior one heptagonal. Radial plates large, wider than high, pentagonal in outline, the distal faces supplied with strong, articular ridges. Anal plate small, resting between the posterior radials upon the distal extremity of the posterior basal, its distal extremity extending beyond the radials. Radianal plate absent.

Remarks.—The genus *Cibolocrinus* is especially characterized by the reduction of the number of underbasal plates to three, and by the presence of a single small anal plate. The only other genus of crinoids at all closely related to this one having a similar number of underbasal plates is *Tribrachiocrinus* from the upper marine series of the Permo-Carboniferous of New South Wales, but *Cibolocrinus* differs from this Australian form in the absence of a radianal plate.

CIBOLOCRINUS TYPUS n. sp.

(Plate I, Figs. 20–22)

Description.—Dorsal cup basin- or low bowl-shaped, nearly hemispherical in form, the surface of all the plates smooth and the sutures flush with the general surface of the cup. The dimensions of the two type specimens are: diameter of dorsal cup 25.8^{mm} and 22.5^{mm}, height of same 11^{mm} and 11^{mm}. Underbasal plates three, forming a pentagonal disk three of whose sides, those opposite the sutures between the plates, are slightly re-entrant, in the larger of the two specimens whose dimensions are given above the diameter of the underbasal disk is 10^{mm}, the columnar facet circular, moderately depressed, occupying about two-thirds of the diameter of the underbasal disk. Basal plates large, as wide or a little wider than high, all except the posterior one regularly pentagonal in general outline, but the anterior pair are really hexagonal although the two proximal faces are nearly a straight line and together are equal in length to the proximal faces of the other two; the posterior basal is a little wider than the others, heptagonal in outline, being similar to the two anterior ones except that its distal extremity is truncated for the support of the anal plate. Radial plates large, wider than high, pentagonal in outline. Anal plate pentagonal, resting between the posterior radials upon the truncate distal extremity of the posterior basal, it is angular distally, its distal extremity reaching beyond the level of the radial plates.

Remarks.—This species has been selected as the type of the genus *Cibolocrinus*, and is established upon two examples of the dorsal cup. No specimen preserving the arms has been observed. The species differs from the other members of the genus here described in its subhemispherical form, all the others being turbinate.

CIBOLOCRINUS TURBINATUS n. sp.

(Plate I, Figs. 23–26)

Description.—Dorsal cup turbinate, the sides diverging with a convex curvature from the margin of the columnar facet to the distal margins of the radial plates, surface of the plates smooth, the sutures not impressed in grooves. The dimensions of a complete dorsal cup are: diameter 25^{mm}, height 17^{mm}. Underbasal plates three in number, one small one anteriorly and two large ones posteriorly, a little more than one-third of the length of each plate at the proximal end is covered by the columnar facet which is in the form of a conelike depression, the exposed distal portions of the plates form the flaring sides of a shallow cup. Basal plates large, the right and left postero-lateral ones nearly symmetrically pentagonal in outline, the two anterior ones hexagonal but with the two proximal faces meeting in a very wide angle so as to form nearly a straight line, the two faces together being equivalent to the single proximal face of the postero-lateral plates, the posterior plate similar to the two antero-lateral ones but with the distal angle truncated to support the anal plate. Radial plates nearly twice as wide as high, pentagonal in outline, their surface curving a little inward near the distal margin, their distal faces bearing strong articular ridges. Anal plate small, resting between the posterior radials upon the truncated distal extremity of the posterior basal, widest between the posterior distal angles of the radial plates on either side, probably pentagonal in outline though the distal portion extending beyond the level of the radials is imperfect in the type specimens.

Remarks.—This species is established upon two individuals, both preserving only the dorsal cup. The most perfect one has exactly the same structure of the dorsal cup as *C. typus*, the two species differing in form and proportions. The second less complete example has the sutures between the underbasal plates obscure, but they seem not to have the same position in the first specimen. The normal position for these sutures, in this and other species of the genus, is beneath the posterior and the two antero-lateral basal plates, those beneath the postero-lateral basals being anchylosed. In the second example mentioned above, these sutures seem to be beneath the posterior and the two postero-lateral basals, so that there are two small plates and one large one formed by the union of the three anterior original underbasals. This is believed to be an abnormal condition in this one individual, since among five examples of the genus in which these sutures between the underbasals can be detected, all except this one have the normal arrangement.

CIBOLOCRINUS TEXANUS n. sp.

(Plate I, Figs. 18, 19)

Description.—Dorsal cup turbinate, the sides diverging with a gently concave curvature from the margin of the colmnar facet, becoming slightly convex toward the distal border of the cup. Surface of the plates smooth, the sutures not impressed in grooves. The dimensions of a dorsal cup are: diameter 21^{mm}, height 14^{mm}. Underbasal plates three in number, large, about one-half their length occupied by the large columnar facet which is in the form of a conical depression in the base of the cup, the distal portions of the plates diverge upward and form the sides of the shallow cup. Basal and radial plates large, similar in form and size to those of *C. turbinatus*. Anal plate small, similar to that in *C. turbinatus*.

Remarks.—This species is closely allied to *C. turbinatus*, but may be distinguished from that species by its much larger columnar facet, and by the concave curvature of the sides of the dorsal cup.

CIBOLOCRINUS SYMMETRICUS n. sp.

(Plate I, Figs. 27–30)

Description.—Dorsal cup turbinate, the sides diverging from the margin of the columnar facet to the distal margins of the radials, the surface of the plates smooth and having the regular curvature of the surface of the cup or sometimes a little convex, the sutures not impressed in furrows. The dimensions of the most complete example are: diameter of dorsal cup 18^{mm}, height of same 13^{mm}. The underbasal plates as in *C. turbinatus*. The basal plates also as in that species except that the posterior one is angular at its distal extremity like the others, not being truncated for the reception of an anal plate. The radial plates also as in *C. turbinatus* except that the two posterior ones are in contact laterally. The anal plate situated above the radials in a notch between the two posterior radials.

Remarks.—This species differs from the other species of the genus here recognized, in having the anal plate crowded out beyond the radials, giving to the dorsal cup a radially symmetrical arrangement of the plates as in the genus *Erisocrinus* except that the number of basal plates is reduced to three. The elimination of the anal plate from the dorsal cup would ordinarily be considered as a good generic distinction, but in the present case there has been some hesitation in separating these specimens even specifically from *C. turbinatus.* In that species the anal plate is much reduced in size and the only distinction between it and the one here described is that in the present form the anal is still further reduced. The species is based upon three individuals, in two of which the sutures between the underbasals can be clearly recognized.

EXPLANATION OF PLATE

(The figures on this plate are reduced to about $\frac{4}{5}$ natural size)

HYDREIONOCRINUS UDDENI n. sp.

FIGS. 1, 2.—Basal and lateral views of the type specimen; 3–5.—Three views of a spinous plate from the summit of the ventral sack, probably belonging to this species. (Pal. Coll. Walker Museum, No. 13363.)

DELOCRINUS MAJOR n. sp.

FIGS. 6, 7.—Basal and postero-lateral views of the type specimen. (Pal. Coll. Walker Museum, No. 13364.)

PHIALOCRINUS AMERICANUS n. sp.

FIGS. 8, 9.—Lateral and basal views of the type specimen. (Pal. Coll. Walker Museum, No. 13369.)

ERISOCRINUS TRINODUS n. sp.

FIGS. 10, 11.—Lateral and basal views of the type specimen. (Pal. Coll. Walker Museum, No. 13368.)

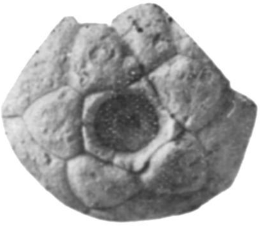
DELOCRINUS TEXANUS n. sp.

FIGS. 12, 13.—Basal and postero-lateral views of the type specimen. (Pal. Coll. Walker Museum, No. 13365.)

ERISOCRINUS PROPINQUUS n. sp.

FIGS. 14, 15.—Lateral and basal views of the type specimen. (Pal. Coll. Walker Museum, No. 13367.)

PLATE I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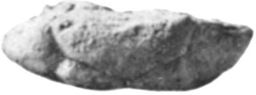
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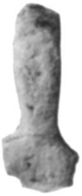
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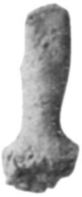
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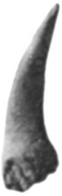
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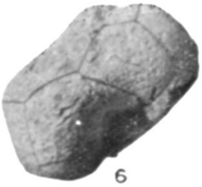
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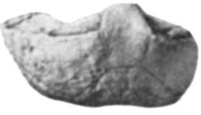
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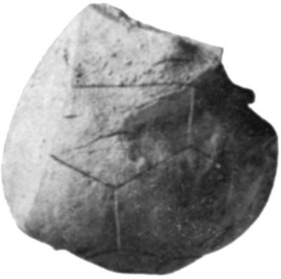
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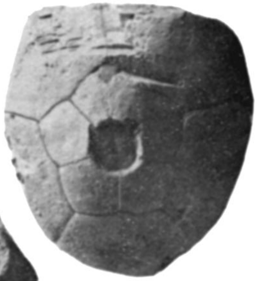
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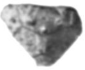
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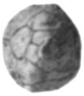
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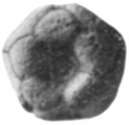
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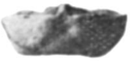
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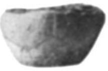
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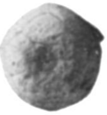
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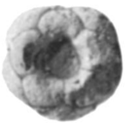
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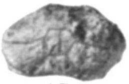
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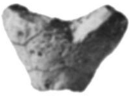
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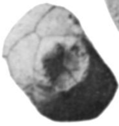
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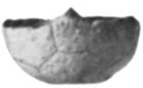
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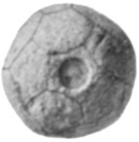
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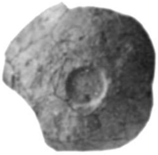
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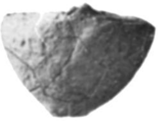
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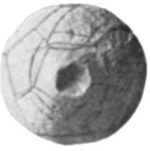
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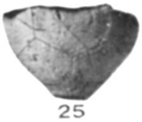
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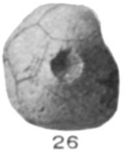
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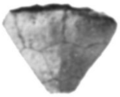
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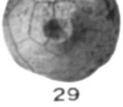
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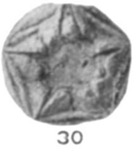
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DELOCRINUS EXCAVATUS n. sp.

FIGS. 16, 17.—Basal and postero-lateral views of the type specimen. (Pal. Coll. Walker Museum, No. 13366.)

CIBOLOCRINUS TEXANUS n. sp.

FIGS. 18, 19.—Lateral and basal views of the type specimen. (Pal. Coll. Walker Museum, No. 13373.)

CIBOLOCRINUS TYPUS n. sp.

FIGS. 20, 21.—Lateral and basal views of one of the cotypes; 22.—Basal view of the other cotype. (Pal. Coll. Walker Museum, No. 13370.)

CIBOLOCRINUS TURBINATUS n. sp.

FIGS. 23, 24.—Postero-lateral and basal views of one of the cotypes; 25, 26.—Lateral and basal views of another of the cotypes. (Pal. Coll. Walker Museum, No. 13371.)

CIBOLOCRINUS SYMMETRICUS n. sp.

FIGS. 27, 28.—Lateral and basal views of one of the cotypes; 29.—Basal view of another of the cotypes; 30.—Ventral view of another of the cotypes, showing the articulating ridges and the small anal plate resting in a notch between the posterior basals. (Pal. Coll. Walker Museum, No. 13372.)